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COMPLETE SPECIFICATION

TIMBER TREATMENT PROCESS

I, STEWART REECE, a citizen of New Zealand of 19 Halfmile Road, Tuatapere, West Southland, New Zealand

hereby declare the invention, for which I pray that a patent may be granted to me and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to a process for treating timber.

Copper-chrome-arsenic formulation preservatives for treating timber have been known for over 60 years. Such preservatives are known as fixed preservatives since they form a chemical bond with the cells of the wood and will not leach out.

The first of the vacuum-pressure processes to be developed for treating timber with these fixed preservatives was the Bethel process, developed in 1838. The principles of that process are still applied in many of the processes used today. Essentially these processes involve placing the timber in a container, introducing an initial vacuum, flooding the container with the treatment solution, pressurising the system for a prolonged period, discontinuing the pressure and reintroducing a vacuum. The solution is removed at the end of the pressure phase and during re-evacuation.

The Bethel Full Cell P. 4 process involves an initial vacuum period of about 20 minutes, flooding of the container in about 10 minutes, raising the pressure over about 20 minutes and maintaining a peak pressure for 45 to 60 minutes, reducing the pressure over 10 minutes and maintaining a vacuum for a further 15 to 30 minutes. The total time of the cycle is approximately 140 minutes, although, as with all processes, this time will vary depending on the particular timber being treated, and on the expected uptake, of the particular timber. The main limitation of this Bethel process is that it is time consuming, and it is the length of the process cycle which determines the productivity of a processing unit. In addition, there is a degree of drip of retained preservative from wood treated in this process. The drip of retained

preservative constitutes an environmental hazard. In contemporary use of this method, preservative which is not retained by the timer is recycled.

A second known process is the Lowry process (e.g. the Lowry Empty Cell P.5 Process). Lowry charges are basically flooded without an initial vacuum, pumped to full pressure over about 20 minutes, peak pressure maintained for 45 to 60 minutes, pressure removed over about 10 minutes, and a further vacuum introduced and maintained for 40 to 45 minutes. Lowry charges are used rarely today because of excessive drip from the timber treated by this process. Its use is also limited to H1 and H3 Hazard levels only.

The Chemicca's Lite and Kopper-Hickson Tan Dry Processes are modified Bethel processes. They involve a low initial vacuum held for 15 minutes at 30-60 kPa, followed by flooding of the container over 10 minutes, pressurisation over 20 minutes, holding the maximum pressure for 3 to 15 minutes, reducing the pressure by means of a slow release valve system over 10 to 14 minutes, a second period under vacuum for 45 to 60 minutes, and 5 minutes to return to normal pressure and complete drainage of the container. These processes involve a total of approximately 155 minutes on average..

With existing processes there is relatively good control over the degree of measurement of timber. However, undercharge (low retention of formulation preservative into timber) or overcharge (excessive retention) is not uncommon. Timber retention and penetration are the critical requirements in timber treatment processes.

Retention is a measure of the amount of chemicals retained by the timber. In particular, it is the concentration of dry chemical salts in one cubic

metre of wood. For example, if a particular piece of wood has a retention of $13.6kg/m^3$, there are 13.6kg of dry chemical in each cubic metre of wood.

The required retention of timber is specified by the appropriate legislating authority in each country in order to prevent fungal and insect attack. Each country sets their own retention level for every hazard specification.

Penetration is a measurement of how far into the wood the chemicals progress. It is usually tested by means of a core boring sample. The penetration may also be tested by means of a sawn biscuit sample.

Sapwood penetration is very easy and is considered automatic.

Different penetration requirements are defined for particular Hazard classes, and the greater the penetration required the longer the pressure time required to achieve this for timber of a particular density. Thus, for example, Hazard H.4 for sawn roundwood has a penetration requirement of full sapwood + 10 mm heartwood. A retention rate of 12.0 kg/m^3 is required to achieve this.

Changes in the control of the timber industry in the last decade have demanded greater attention to environmental considerations and to the quality and consistency of treated timber. Occupational health and safety laws must also be complied with.

The present invention has been directed at providing an efficient process which enables the production of timber treated to a more consistent standard, irrespective of the variation and quality of the timber, and also to

produce an essentially drip-free product. The present invention is also directed to comply with the Health and Safety in Employment Act 1992, which requires the minimisation of chemical hazards.

Thus, it is an object of the present invention to provide a process for treating timber, which overcomes at least some of the abovementioned problems, concerning drippage, efficient utilisation of equipment and consistency of treatment, or which at least provides the public with a useful alternative choice.

According to one aspect of the present invention there is provided a timber treatment process comprising the steps of:

i) exposing a charge of timber in a container to a first reduced pressure phase;

ii) introducing preservative solution into the container whilst the reduced pressure is maintained;

iii) increasing pressure in the container by pumping a predetermined further quantity of preservative solution into the container;

iv) maintaining the pressure in the container;

v) releasing the pressure and recovering and measuring blown back solution;

vi) exposing the charge of timber to a second reduced pressure phase; and

vii) releasing the vacuum and recovering any remaining solution.

Preferably, the preservative solution includes fixed preservatives. Most preferably, the preservative solution is a copper-chromium-arsenic formulation.

In a preferred form of the invention the concentration of preservative solution is calculated according to a required retention for the timber to be treated and an expected uptake for that timber, according to the formula:

$$\frac{\text{required retention (kg/m3)}}{\text{expected uptake (L/m}^3\text{)}} \times \frac{100}{1} = \text{solution strength (\%)}$$

In a preferred form of the invention the first reduced pressure phase is applied for a maximum of 10 minutes, to achieve a maximum vacuum in the container of -60 kPa, and a preferred vacuum in the timber of -30 kPa. After the first reduced pressure phase, the pressure can be increased to above 1400 kPa, and preferably above 1550 kPa, for 3 to 15 minutes. The second reduced pressure can be held at or below -80 kPa for 30 to 60 minutes, or preferably until the charge is of sufficient dryness as to be non-drip or to produce only a minimal drip after an hour on a drip pad.

In a further preferred form of the invention the rate of rise of pressure in the container after the first reduced pressure phase can be gradual, over a period of 6 to 20 minutes, and preferably at least 10 minutes.

The further quantity of preservative solution pumped into the container under pressure is preferably calculated from the initial displacement volume (D.V. in) of the timber and the expected uptake of that timber according to the formula:

$$\text{D.V. in (m}^3\text{)} \times \text{expected uptake (L/m}^3\text{)} = \text{volume to be added (L).}$$

Preferably 200 to 500 L of excess fluid are pumped into the container in addition to the further quantity of preservative referred to above.

If fixed preservatives are employed, the process further can comprise withdrawing the timber from the container after the second vacuum phase and placing it on a drip pad for a fixation period, preferably of at least 12-13

hours. Heat can be employed to reduce the fixation period. If heat is used, a heat absorbent cover can be placed over the timber to further reduce the fixation period.

Other aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to Figure 1 which accompanied the provisional specification, and which shows variations in pressure with time for a variety of different timber treatment processes including that of the present invention.

The process of the present invention can be utilised with standard pressure treatment plants. Such plants essentially comprise a sealable cylinder in which the timber is to be treated, a storage tank for holding the preservative solution interconnected with the cylinder, and means for introducing a vacuum and pressure into the cylinder. The interconnection between the storage tank and the cylinder enables the cylinder to be flooded with preservative solution, and used solution to be returned to the storage tank at the end of a treatment cycle.

The process of the present invention is commenced by placing timber in the cylinder and securing the cylinder door. A vacuum is then introduced into the cylinder. In order to achieve a required actual vacuum in the wood of -30 kPa the pressure in the chamber should be reduced to -35 kPa to -60 kPa. However, this first vacuum phase is only short, the vacuum pump being held for only 10 to 15 minutes, and preferably only about 10 minutes.

The cylinder is then flooded with preservative solution from the storage tank. The vacuum pump is left on until the cylinder has completely filled at

which time it is turned off. It will therefore be appreciated that the cylinder is filled with preservative solution as quickly as possible.

The pressure cycle of the process now begins. Pressure should preferably be increased in the cylinder gradually over a period of approximately 10 to 20 minutes. A shorter period is acceptable, but not less than 6 to 8 minutes. It is important that a relatively slow rate of pressure build up is employed to be consistent with the rate of ingress of solution into wood. Some pumping systems (for example a Centrifugal Multistage Pump) enable much more rapid pressurisation.

Once the cylinder is full, a further amount of solution is pumped into the cylinder to increase the pressure. The amount pumped in must be at least equivalent to the expected uptake of solution for the quantity of timber being treated plus a further 200 to 500 L above this level. The latter amount should be added since at least this excess will be drawn back during the second vacuum step.

The further amount of solution to be pumped into the cylinder is determined according to the anticipated uptake in L/m^3 of the timber in the cylinder and the displacement volume of the timber placed in the cylinder (D.V. in). Thus, for example, 4.20 m^3 of kiln dry posts having an anticipated uptake of 500 L/m^3 would require 2,100 L of fluid for treatment (4.20 m^3 x 500 L/m^3) plus the extra 200 to 500 L.

The process of the present invention can accommodate timbers having anticipated uptakes or absorption rates in the range 200 to 500 L/m^3.

The pressure in the cylinder should reach at least 1,400 kPa, and should be retained in the range 1,400 to 1,600 kPa, preferably 1,430 kPa, for a period of a few seconds to 60 minutes, preferably about 2 to 3 minutes. The pump is then switched off to allow blow back.

"Blowback" is the return of solution under pressure into the storage tank. This first stage of blowback should be allowed to continue to completion (apparent when there is no further rise of solution in the tubes to the storage tank) to enable accurate calculation of the Displacement Volume Out (D.V. out).

The Displacement Volume Out is the standard or true measurement of the timber charge, and is used to calculate final treatment results. When the pressure cylinders and other auxiliary equipment, for example, tank gauges are installed, the volume of liquid held is measured by flooding the equipment. By measuring the amount of solution blown back (DV OUT), the volume of the timber immersed in the solution can be determined. The Displacement Volume In can not be used, as some solution penetrates the wood whilst flooding is under way.

There is no particular rate of flow requirement during the pumping step in the process of the present invention. Nor is it necessary to pump to refusal.

Optionally a pressure switch may be utilised at full pressure to switch on a timer circuit, the timer being set by the operator to switch the pump off after a predetermined time. The circuit may also incorporate an alarm or bell to alert the operator when the pump is switched off.

The vacuum pump is now switched on again to begin the second vacuum cycle. This vacuum cycle lasts for 30 to 60 minutes, approximately 40 minutes on average, at full vacuum (-90 kPa to -80 kPa). The precise duration of this cycle is determined by the type of product being treated. Timber of smaller cross section is readily vacuum dried in 30 minutes, whilst timber of larger cross section requires a longer time.

The vacuum pump is then switched off and remaining solution is returned to the storage tank (second blowback). The treated timber or charge may then be removed from the cylinder and transferred to a drip pad for a specified amount of time or until no drips are noticed.

Experienced operators will be able to time the second vacuum cycle for any particular type of produce being treated so that the timber is of sufficient dryness to be non-drip, or with only a minimal drip noticeable after an hour on the drip pad. It has been found that heartwood predominant timbers require specific attention as compression factors cause excess drippage.

It has also been found that gauged timbers often have a layer of solution, the "meniscus", between boards. Packets therefore need to be elevated at one end of the drip pad to allow this layer to run off.

If fixed preservatives are used, the final step of a timber preservative process is the fixation step, which is the time required for the chemicals to bond irreversibly to the timber, and this step occurs primarily on the drip pad. It is a temperature sensitive process which is inhibited at low temperatures. The processes of the present invention anticipate the use of the known fixation step, namely leaving the treated timber on the drip tray for a specified period of time above a certain minimum temperature.

The process of the present invention can employ known preservative formulations incorporating chromium, copper and arsenic. For example, Tanalith C 60, which comprises 44.3 to 58% w/w chromium, 32.5 to 33.3% w/w copper and 19.0 to 20.6% w/w arsenic, or BTB Type C, comprising sodium dichromate 40%, conper sulfate 35% and arsenic acid 25%. It will be appreciated that the process of the present invention is not restricted to processes employing these particular solutions and that other copper/ chromium/arsenic wood preservatives, or other fixed preservatives, would be equally applicable to the process.

The actual strength of solution selected for treatment of any particular charge of timber must be determined from the required retention in kg/m^3 of timber and the expected uptake in L/m^3 of timber, according to the following formula:

$$\frac{\text{required retention (kg/m}^3\text{)}}{\text{expected uptake (L/m}^3\text{)}} \times \frac{100}{1} = \text{s/s\%}$$

For example, for a charge of kiln dried posts requiring Hazard H.4:

Hazard H.4 = required retention of 12.0 kg/m^3,

Kiln dried posts expected uptake = 500 L/m^3,

$$\text{Retention} = \frac{12.0}{500} \times \frac{100}{100} = 2.40\% \text{ solution}$$

This solution strength is much stronger than that used in the standard Bethel process. Fixation is greatly enhanced by the increase in solution strength, particularly in warm dry conditions.

The concentration of the solution can be tested in the storage tank by means of a refractometer. The purpose of this is two-fold, namely:

1) To confirm the concentration of the solution being used in the current

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treatment.

2) To determine the concentration of the solution for the next treatment.

Example:

The minimum requirements of the New Zealand Timber Council (SANZ-MP 3640:1992) for Hazard Class 4 are as follows:

Penetration: Complete sapwood penetration with a minimum of 10mm sapwood penetration is required in not less than 90% of samples in a set.

Retention: A minimum concentration of 0.16% copper plus a minimum concentration of total active elements of 0.72% is required in not less than 90% of samples, in the outer 25mm retention zone or the full sapwood depth where sapwood is between 10mm and 25mm, assuming a basic density of $400 kg/m^3$ and Class 1 preservative.

The following results were obtained:

	mm Sapwood /mm Penetration	Copper %w/w	Chromium % w/w	Arsenic % w/w
1.	65/80	0.31		
2.	65/65	0.29		
3.	85/85	0.21		
4.	60/60	0.29		
5.	80/80	0.31		
6.	15/65	0.[illegible]3		
7.	70/70	0.25		
8.	75/75	0.30		
9.	60/70	0.27		
10.	60/60	0.31		

	mm Sapwood /mm Penetration	Copper %w/w	Chromium % w/w	Arsenic % w/w
1.	75/75	0.23		
2.	60/60	0.37		
3.	35/75	0.31		
4.	72/72	0.33		
5.	80/80	0.24		
6.	60/60	0.34		
7.	75/75	0.31		
8.	70/75	0.32		
9.	40/80	0.30		
10.	50/50	0.30		

	mm Sapwood /mm Penetration	Copper %w/w	Chromium % w/w	Arsenic % w/w
1.	40/80	0.34		
2.	65/80	0.32		
3.	80/80	0.26		
4.	50/70	0.36		
5.	40/55	0.31		
6.	70/70	0.27		
7.	95/95	0.31		
8.	67/67	0.30		
9.	40/59	0.34		
10.	80/80	0.22		

	mm Sapwood/ mm Penetration %w/w	Copper % w/w	Chromium % w/w	Arsenic Active Elements % w/w	Total
1.	10/65	0.19			
2.	40/70	0.16	0.26	0.12	0.54
3.	25/60	0.30			
4.	55/65	0.30			
5.	67/67	0.33			
6.	40/62	0.23			
7.	67/67	0.25			
8.	60/70	0.27			
9.	60/70	0.21			
10.	20/75	0.23			

These sets of samples all complied with the penetration and retention specifications.

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Example 2:

The minimum requirements of the New Zealand Timber Council (SANZ-MP 3640:1992) for Hazard Class 3 are as follows:

Penetration: Complete sapwood penetration is required in not less than 90% of the samples in a set.

Retention: Not less than 90% of samples contain a minimum, of 0.08% copper, 0.16% chromium and 0.11% arsenic, with a minimum of 0.37% total active elements. Full analyses are required when the percentage of copper is 0.08-0.09.

The following results were obtained:

Set 1:

	mm Sapwood/ mm Penetration %w/w	Copper % w/w	Chromium % w/w	Arsenic Active Elements % w/w	Total
1.	100/100	0.18	0.20	0.17	0.55
2.	100/100	0.14	0.18	0.13	0.46
3.	100/100	0.21	0.25	0.17	0.63
4.	100/100	0.22	0.19	0.17	0.59
5.	Heartwood				
6.	Heartwood				
7.	90/100	0.23	0.40	0.29	0.93
8.	100/100	0.17	0.25	0.24	0.66
9.	100/100	0.14	0.16	0.15	0.46
10.	95/100	0.20	0.24	0.17	0.61

	mm Sapwood/ mm Penetration %w/w	Copper % w/w	Chromium % w/w	Arsenic Active Elements % w/w	Total
1.	80/100	0.20	0.26	0.[illegible]5	0.71
2.	100/100	0.15	0.23	0.22	0.59
3.	Heartwood				
4.	30/60	0.09	0.12	0.21	0.42
5.	20/60	0.30	0.17	0.29	0.76
6.	70/90	0.16	0.21	0.26	0.63
7.	30/90	0.17	0.23	0.30	0.69
8.	100/100	0.20	0.17	0.23	0.60
9.	100/100	0.14	0.16	0.15	0.46
10.	100/100	0.17	0.21	0.18	0.56

	mm Sapwood/ mm Penetration %w/w	Copper % w/w	Chromium % w/w	Arsenic Active Elements % w/w	Total
1.	15/100	0.20			
2.	Heartwood				
3.	100/100	0.15			
4.	Heartwood				
5.	Heartwood				
6.	30/50	0.16			
7.	50/60	0.17			
8.	15/50	0.07			
9.	Heartwood				
10.	100/100	0.14			

These sets of samples all complied with the penetration and retention specifications.

Estimation of expected uptakes is generally gained by operator experience. Treatment plants should keep log books recording the expected uptake of timber according to source, species, type of produce and seasonal influences. On average the expected uptake for air dry material is approximately 360 to 420 L/m^3, while that for kiln dried material is closer to 500 L/m^3.

In addition, the process of the present invention employs a "window" system for operator assessment of timber penetration. "Window" in this context is used to describe a method in which operators can obtain wood boring samples for visual assessment of the extent of treatment solution penetration and on which to apply chemical spot tests. Recordal of the results of such visual assessment and chemical spot tests enables an operator to build up a general view of treatment performance over time. Upon analysing the results over a period of time, operators should find that they are able to predict the absorption uptake with some accuracy.

Although the invention has been described by way of example and with particular reference to a preferred embodiment, it should be appreciated that variations and modifications may be made thereto, without departing from the scope of the invention.

WHAT I CLAIM IS:

1. A timber treatment process comprising the steps of:

- exposing a charge of timber in a container to a first reduced pressure phase;

- introducing preservative solution into the container whilst the reduced pressure is maintained;

- increasing pressure in the container by pumping a predetermined further quantity of preservative solution into the container;

- maintaining the increased pressure in the container;

- releasing the pressure, and recovering and measuring blown back solution;

- exposing the charge of timber to a second reduced pressure phase; and

- releasing the vacuum and recovering any remaining solution.

2. A timber treatment process as claimed in claim 1 wherein the first reduced pressure phase is applied for a maximum of substantially 10 minutes.

3. A timber treatment process as claimed in claim 1 or claim 2 wherein pressure in the container during the first reduced pressure phase is a maximum of substantially - 60 kPa.

4. A timber treatment process as claimed in any one of the preceding claims wherein pressure in the timber during the first reduced pressure is substantially - 30 kPa.

5. A timber treatment process as claimed in any one of the preceding claims wherein the concentration of the preservation solution is

dependant upon a required retention of the timber, and an expected uptake for the timber.

6. A timber treatment process as claimed in claim 5 wherein the concentration of the preservative solution is determined according to formula:

$$\frac{\text{required retention (kg/m}^3\text{)}}{\text{expected uptake (L/m}^3\text{)}} \times \frac{100}{1} = \text{solution strength (\%)}$$

7. A timber treatment process as claimed in any one of the preceding claims wherein after the first reduced pressure phase, pressure is increased to at least 1400 kPa.

8. A timber treatment process as claimed in claimed in any one of the preceding claims wherein after the first reduced pressure phase, pressure is increased at least 1550 kPa.

9 A timber treatment process as claimed in any of the preceding claims wherein after the first reduced pressure phase, the pressure is increased over a period of 6 to 20 minutes.

10. A timber treatment process as claimed in claim 9 wherein the pressure is increased over a period of at least 10 minutes.

11. A timber treatment process as claimed in any one of the preceding claims wherein the increased pressure is maintained for 3 to 15 minutes.

12. A timber treatment process as claimed in any one of the preceding claims wherein the further quantity of preservative solution pumped in

the container is calculated from the initial displacement volume (DVin) of the timber and the expected uptake of the timber according to the formula:

D.V. in (m^3) x expected uptake (L/m^3) = volume to be added (L).

13. A timber treatment process as claimed in claim 12 wherein an additional 200 to 500 L are pumped into the container in addition to the quantity calculated.

14. A timber treatment process as claimed in any one of the preceding claims wherein the timber is exposed to the second reduced pressure phase for 30 to 60 minutes.

15. A timber treatment process as claimed in any one of the preceding claims wherein the pressure in the container during the second reduced pressure phase is a maximum of substantially - 80 kPa.

16. A timber treatment process as claimed in any one of the preceding claims wherein the pressure during the second reduced pressure phase and the time for which the timber is exposed to the second reduced pressure phase is such that the timber is of sufficient dryness as to be non-drip or produce only a minimal drip after substantially one hour on a drip pad.

17. A timber treatment process as claimed in any one of the preceding claims further including the step of:

- withdrawing the timber form the container after the second reduced pressure phase.

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18. A timber treatment process as claimed in any one of the preceding claims wherein the preservative solution includes fixed preservatives.

19. A timber treatment process as claimed in claim 18 of the preceding claims wherein the preservative solution is a copper-chromium-arsenic formulation.

20. A timber treatment process as claimed in claim 18 or claim 19 further including the step of:

- placing the timber on a drip pad for a fixation period.

21. A timber treatment process as claimed in claim 20 wherein the fixation period is substantially 12-13 hours.

22. A timber treatment process as claimed in claim 20 wherein the fixation period is reduced by applying heat to the timber.

23. A timber treatment process substantially as herein described with reference to the drawing accompanying the provisional specification.

24. Timber when treated according to the process claimed in claim 1.

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